2. Automated Data Entry and an Internet Based Pest Alert System

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Introduction Recent advances in Information Technology (IT) impact plant protection. There are two technologies that are particularly applicable to plant protection. The first is Geographic Information System (GIS) software that is frequently used in modern plant protection. Another IT element applicable to plant protection is the database concept. Database and GIS software can form a very powerful symbiosis in plant protection if they are correctly organized and implemented. GIS software has the capability to connect to databases (local or remote) using a variety of methods. If the sampling locations are georeferenced using GPS, survey data can be analyzed and interpreted using the arsenal of powerful GIS analytic tools.

Our Area Wide Pest Management Project (AWPMP) involves teams of entomologists and weed scientists from six states situated on the Great Plains of the USA: Colorado, Kansas, Nebraska, Oklahoma, Texas, and Wyoming. A goal of the AWPMP is to monitor aphid populations regionally and to establish the causes for pest outbreaks.

Data Collection We established 23 typical production winter wheat fields (Fig. 1) throughout our study region. On each field we established 25 regularly distributed sampling points that are georeferenced using GPS. Sampling each field is accomplished using several methods: field sampling that includes a series of counts of aphids and their predators and parasitoids; Berlese sampling to establish the aphid species and their density; emergence canister sampling to establish the intensity of parasitism and parasitoid species; and sampling weeds that can serve as alternative hosts for aphids. For each method we developed a simple template on a Pocket PC using FarmWorks SiteMate© that facilitates entry of field data. The Pocket PC is equipped with a GPS for georeferencing sampling points. The structure of the sampling data collected in the field contains the majority of indexes included in all sampling data. The place and the sampling method are determined by longitude, latitude, elevation, object ID, state, county, grower, crop, date, growth stage, pest unit, predator unit, and weed unit for sampling. The aphid species are Bird Cherry-oat Aphid (BCOA) - *Rhopalosiphum padi* (L.), Greenbug (GB) - *Schizaphis graminum* (Rondani), Russian Wheat Aphid (RWA) - *Diuraphis noxia* (Mordvilko), Other aphids (In this group are the Corn leaf aphid (*R. maidis*), the English grain aphid (*Sitobion avenae*), and rice root aphid (*Rhopalosiphum rufiabdominalis*). Black and gold mummies are counted separately to distinguish the two groups of parasitoids. In the predator group the more important species are distinguished individually, e.g. *Hippodamia convergens*, *Coccinella septempunctata*, *Coleomegilla maculata*, and *H. sinuata.* But some predators that correspond to the same genus (tribe, family, etc.) we combine as a single entry to reduce the volume of collected information. These groups include spiders, nabids, carabids, staphylinids, syrphids, Geocoris, Orius, Scymnus, green lacewings, and brown lacewings. We also sample other important pests such as pest mites, fall armyworm, armyworm, army cutworm, and the important weeds.

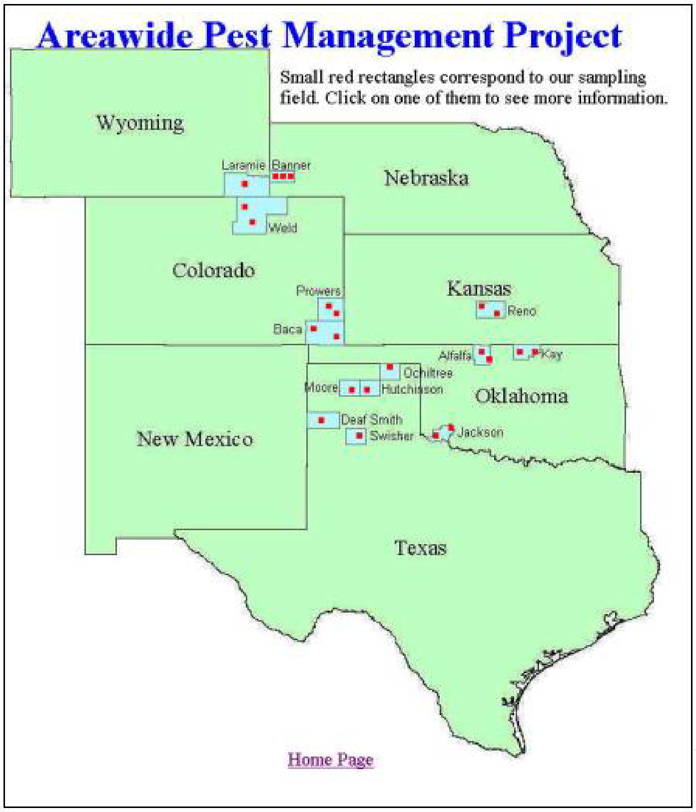


Fig. 1

Database Development and Implementation We organized a computer with Windows 2003 Server © operating system and installed Oracle 9i© on it. We developed a database on the server with a structure that corresponds to the field collected data (Fig. 2). Using Microsoft Visual Studio© we developed a client – server application that allows all project participants involved in AWPMP to visualize, input, and correct their collected data from their computers. On our ftp site at the address ftp://199.133.145.58/ we published the instructions on how to install and use the database software. Once a file with field sampling data is downloaded from the Pocket PC to a Desktop PC we can download the data in Excel format to visualize and make any necessary corrections. The Visual Basic software we developed is able to read Excel tables, to check the structure of these tables, and to localize any errors with corresponding prompts. After that process, the data from the Excel tables is directly incorporated into a common Oracle 9i project database (Fig. 3). Each Excel table has a Constant part and a Variable part of information. The Visual Basic application will separate these two parts and will put them in corresponding database tables that are linked logically by a common key.

The Visual Basic application implements OO4O (Oracle Objects for OLE) that is a part of the Oracle Net Manager Tool ©. OO4O facilitates the pr ogramming work in the Visual Studio environment. Oracle Net Manager is installed on each PC involved in our project and it is responsible for establishing a secure link with our remote database. We chose the Oracle products because they are efficient and stable. In Fig. 4 is a simplified flowchart of the structure of the application.

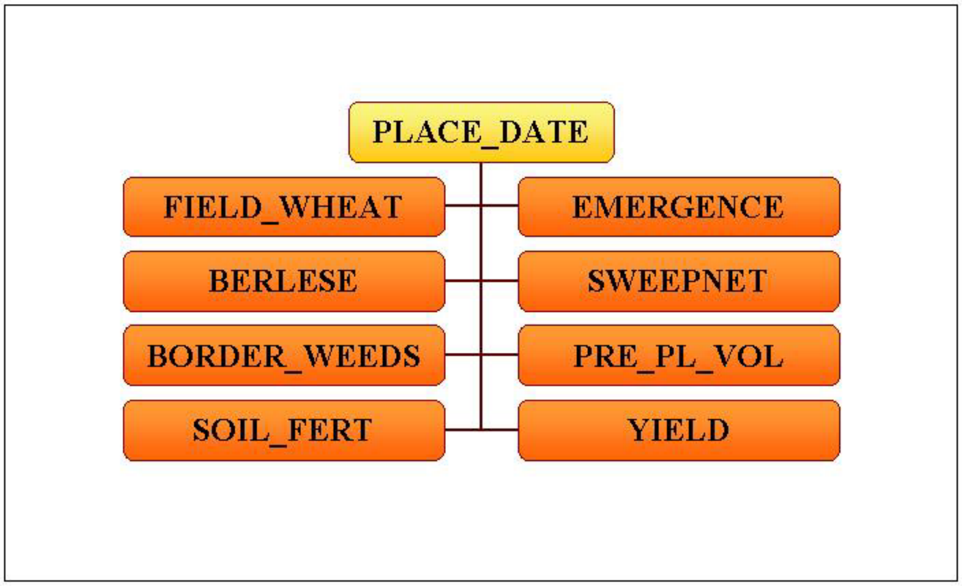


Fig. 2

Input Data Application Interface

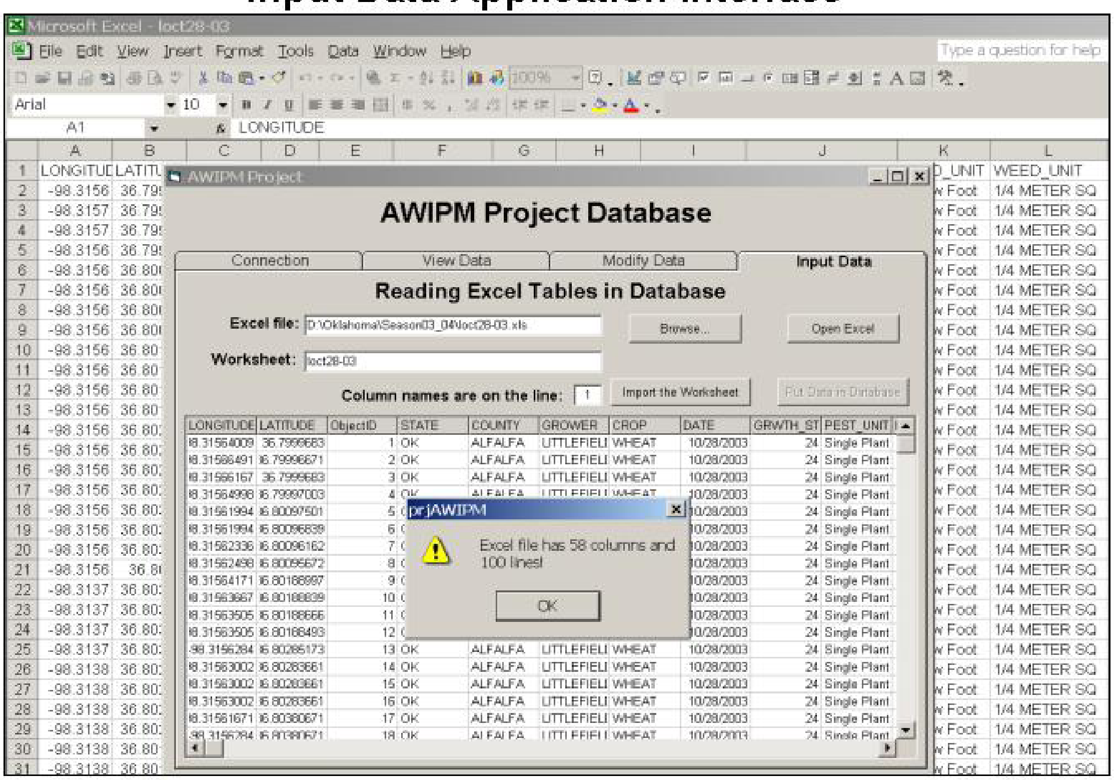
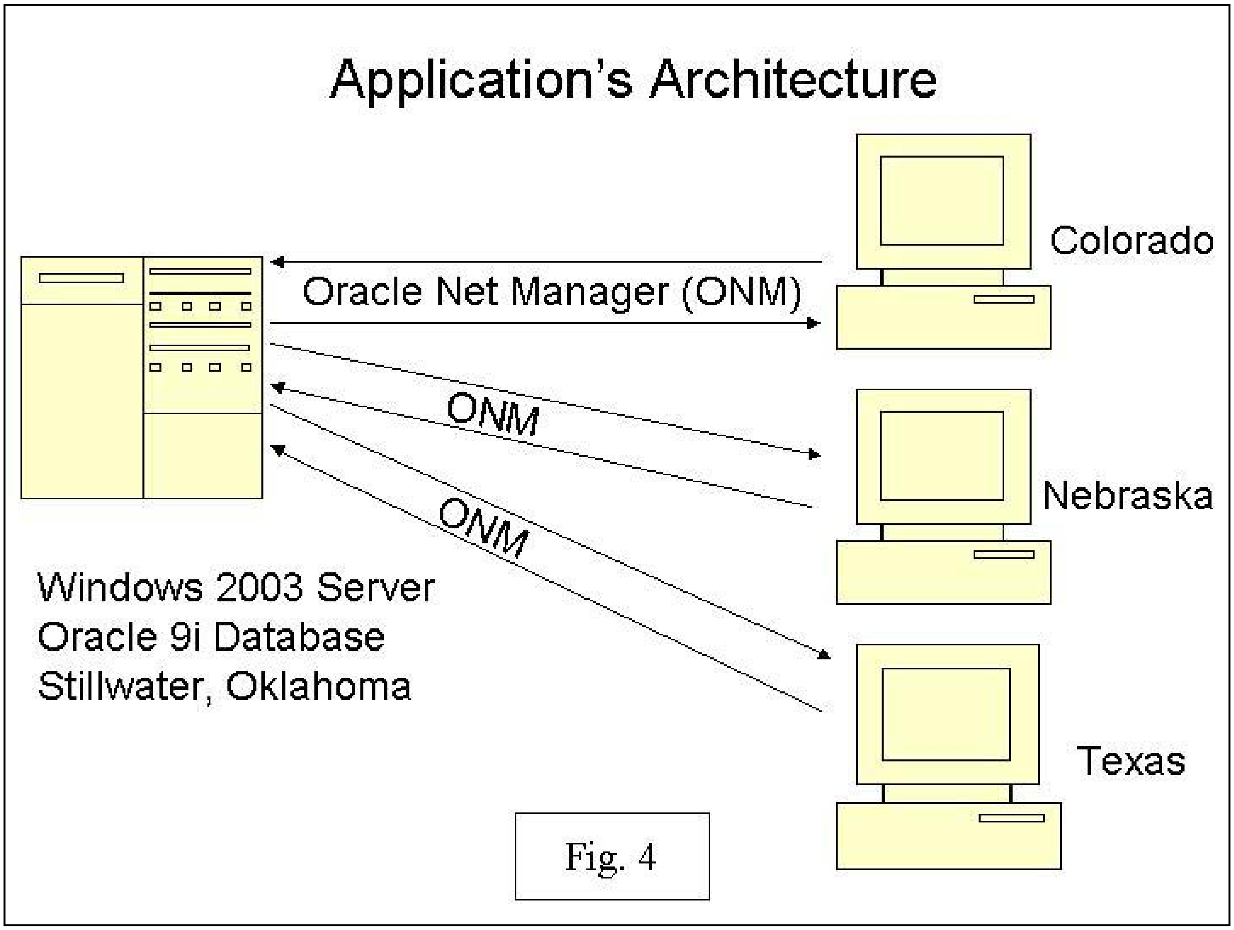


Fig. 3



AWPMP Perspectives. In the future we hope to develop a larger infrastructure based on our Oracle database. First of all we can link the database with GIS software and make analyses of aphid populations at regional scale. We can more precisely conduct our project and establish new conformity to natural laws. We can use the theory of landscape and metapopulation ecology to interpret results. Secondly, we can develop WEB applications that will be linked with the Oracle database to provide near real- time updates to growers of current pest conditions in their region. Fig. 1 represents the beginning of this kind of work. This is the start page of our future Web application. We can develop graphical methods for data interpretation to facilitate the spatial – temporal visualization of pest population dynamics across the region. An exciting and interesting application of the database is development of some forecasting methods to predict the pest population evolution, to detect the preliminary environmental conditions that can cause a pest outbreak, and to determine the role of predators and parasitoids in pest population regulation. This is an important objective of the project because we will have the ability to study the dynamics of insect populations and their interaction using a spatial – temporal approach. Figs 5 - Fig. 8 represent an attempt to describe the evolution of a aphid population in one of our sampling fields in Oklahoma, Jackson county. Figs. 9 - 10 represent the predator population in the same field. The surfaces are constructed using a Kriging procedure from SAS©.

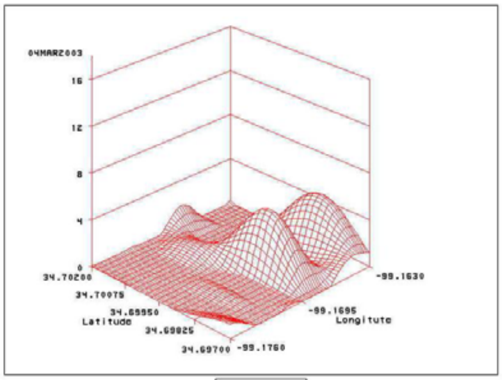


Fig. 5

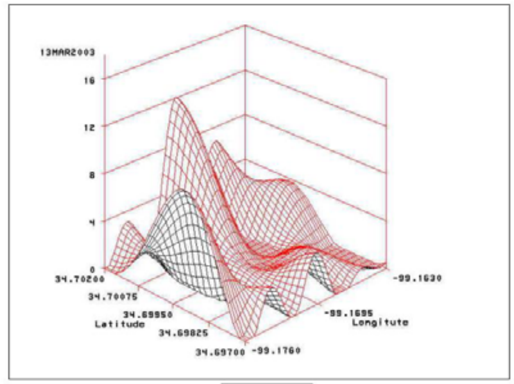


Fig. 6

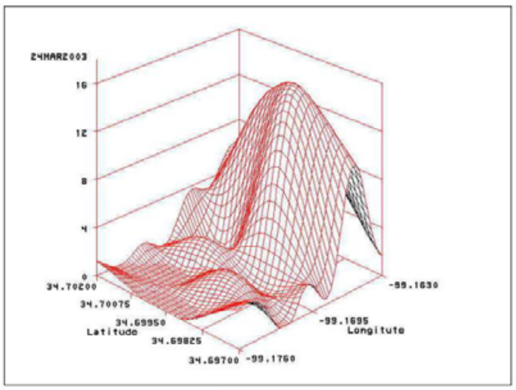


Fig. 7

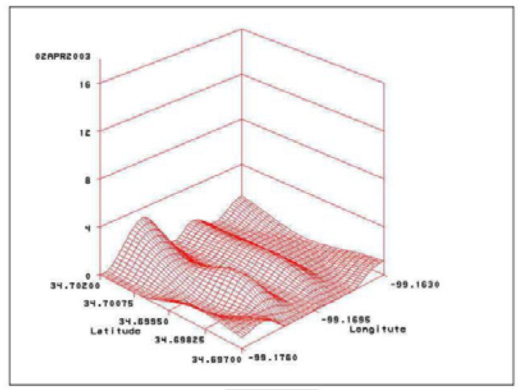


Fig. 8

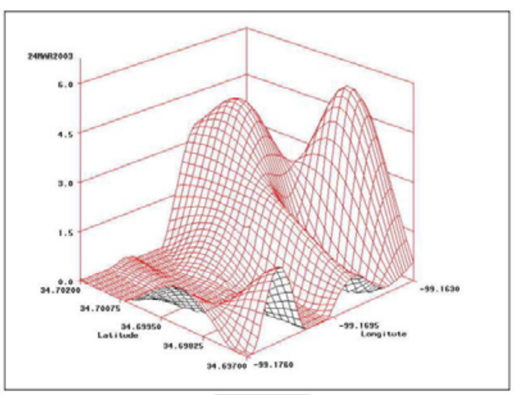


Fig. 9

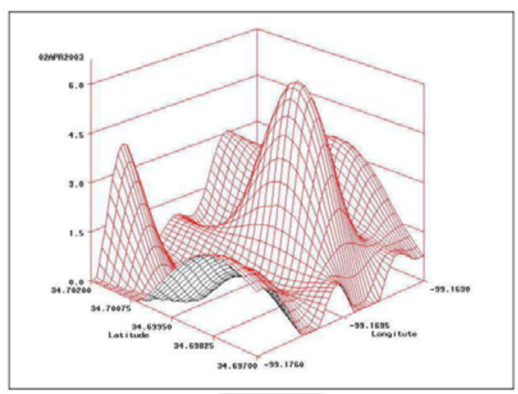


Fig. 10